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ABSTRACT

This manual is intended to assist in developing augmentative communication systems for deaf-blind children. After a brief introduction, section II provides an overview of general augmentative communication systems and theory. Section III presents a general decision-making process for developing and selecting augmentative communication systems for nonspeaking individuals. Techniques for assessing needs, the current communication system, and potential changes in the communication system are discussed. Nineteen systems of nonverbal communication are described, as are 10 communication aids, and contact information for companies producing and distributing the aids is provided. A form for relevant motor assessment is also presented. (94 references) (PB)

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AUGMENTATIVE COMMUNICATION FOR CHILDREN WITH DEAF-BLINDNESS: GUIDELINES FOR DECISION-MAKING

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AUGMENTATIVE COMMUNICATION FOR CHILDREN WITH DEAF-BLINDNESS:

GUIDELINES FOR DECISION-MAKING

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PREFACE

Perhaps no handicapping condition is as debilitating as the dual sensory impairment of deaf-blindness. All too often, young children with this type of condition have difficulty developing even rudimentary communication skills. This situation is further exacerbated by a relative absence of systematic research, assessment tools, and curricula expressly designed for persons with deaf-blindness. Fortunately, in recent years, the professional community has directed more attention to this population, and various research endeavors have been initiated to develop appropriate and useful materials.

One such effort is the Communication Skills Center for Young Children with Deaf-Blindness (CSC). This project was funded through a 5-year contract that was awarded in 1983 to the Teaching Research Division of the Oregon State System of Higher Education by the United States Office of Special Education and Rehabilitation. The overall goals of CSC were to develop, implement, evaluate, and disseminate communication interventions to increase the early communication and language competencies of young children (0 to 5 years) with deaf-blindness. Toward this end a multisite, consortium model was adopted. The CSC was administered through the Teaching Research Division and included as members the Portland, Oregon, Public Schools; University of Wisconsin-Madison, Waisman Center; St. Luke's Hospital, New York; and Utah State University, Exceptional Child Center. At each of these sites specific topics related to communication development in children with deaf-blindness were investigated.

This manuscript is only one of the products generated from the project. It is our hope that the document will be both interesting and helpful to the reader; and that, in some way, it will aid children with deaf-blindness.

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SECTION I

INTRODUCTION

A. Overview and Purpose of Manual

This manual is intended to be a tool for rehabilitation personnel, teachers, therapists, caretakers, and clients to assist in developing augmentative communication systems. Persons with deaf-blindness have difficulty using standard verbal communication techniques because of limited access to visual and auditory channels of information transmission. Children with impaired vision and speech are at risk for developing verbal communication skills as well as language and interaction skills, because of limited experience with language reception, expression, and application in functional settings.

Nearly all persons with deaf-blindness need some form of assistive communication for managing communicative interactions. As used by this manual, augmentative or assistive communication has a very broad definition: any behaviors, activities, materials, or techniques that help a person convey and receive messages, in addition to verbal language. Nondisabled persons routinely use natural nonverbal behaviors such as facial expressions and gestures to augment verbal communication, although their verbal message is generally adequate without this information. Persons who have more difficulty with producing or understanding verbal language may use a combination of nonverbal behaviors, gesture systems and signs, actions, vocalizations, symbols, communication boards, and electronic devices to send and receive information. A person's augmentative system, then, is their particular combination of these communication techniques used across different settings, persons, and purposes. An augmentative system is not a single decision made once in a person's lifetime, but an ongoing, constantly changing process of determining what is the most effective means to communicate in a given situation.

The manual is structured according to basic decisions about augmentative communication applications, because similar things must be decided for all individuals. The focus is to discuss issues that are liable to occur in developing a system to meet a person's communicative needs, and to cover as complete as possible a range of concerns. Specific implementations or modifications of general techniques for deaf-blind individuals are covered with each step in the decision process. Equipment and resources specific to deaf-blind are covered in section IV and the appendices.

B. What is Deaf-Blindness?

Deaf-blindness is a double disability, which includes the functional problems of both hearing and sight loss, as well as unique problems associated with the combined disability. To be labelled deaf-blind, a person must be either a) legally blind or legally deaf, with enough associated vision or hearing impairment to significantly affect functional use, or b) severely hearing and vision impaired, with only residual sight and/or hearing. Thus, a person need not be totally deaf (unable to hear and understand speech, even with amplification) and blind (20/200 or 20/250 vision with maximum correction, and/or tunnel vision of 20 degrees or less) to be labelled deaf-blind (Gallaudet, 1980). In some cases, the term "blind-deaf" is used if a peron's first or primary disability is blindness. An estimated 20-30,000 persons in the United States are considered deaf-blind (Zuckerman, 1983).

C. Causes of Deaf-Blindness

One of the most common causes of deaf-blindness is maternal rubella, dating particularly from the rubella epidemic of the 1960's. Another common cause is Usher's Syndrome, which combines early deafness with progressive blindness from retinitis pigmentosa. Other common causes of blindness (such as cataracts, glaucoma, or accidents) or deafness (such as otosclerosis, high fevers, or tumors) may affect someone who is already deaf or blind, and result in functional deaf-blindness. The cause and time of onset of sight and hearing loss have a great influence on the communicative and behavioral implications of deaf-blindness.

Sometimes deaf-blind children also have other health problems such as motor impairments and mental retardation associated with the primary etiology. Typically, deaf-blind infants behave differently from other infants in three ways: 1) they remain passive and unresponsive to apparent stimuli; 2) they react vigorously, protectively and with hypersensitivity to most all handling attempts; and 3) they cry whether being handled or left alone (Mouchka, 1971). Because these children are more often passive than other children, the job of the caretaker and therapist is to bring the world to the child at the child's developmental level.

D. How to use this Manual

This manual outlines issues affecting decision processes for augmentative communication intervention, highlights points of particular concern for deaf-blindness, and recommends possible courses of action or additional resources. Application of augmentative communication aids in general cannot be reduced to a simple step-by-step process because of the necessity of incorporating multiple factors about the individual's skills, experience, knowledge, motivation, environment, and availability of tools and resources to meet their needs. This process is further complicated by the high degree of variability in persons with deaf-blindness. This manual is best

used as a framework, or resource for assessment and application of augmentative systems. It provides an overview of what should be assessed, some ideas and procedures for intervention, but cannot possibly cover the implications of a given assessment for any particular client or aid.

Some of the suggestions or issues raised may not apply to a particular client for whom system recommendations are in process. The wide range of topics covered are intended not only to broaden the range of potential application, but to suggest issues that might not occur within a limited focus for a single client. For instance, details about positioning of communication devices pertain most directly to persons with physical impairments. However, raising this issue may prompt reassessment of placement of educational activities within a classroom for deaf-blind children, out of similar concern for accessibility of materials.

This manual addresses concerns of persons who have attained prerequisite skills for language development (see Section III for further information on prerequisites). Thus, the first step in assessing a client for an augmentative system is to determine whether such a system is appropriate at this time. It is necessary to build basic communication interaction skills, if insufficient, as a preliminary step leading to communication aid application. Assessment and training procedures designed to improve cognitive/social skills underlying initial communicative behavior are detailed in the Early Communication Skills Curriculum (Higginbotham, Mathy-Laikko, Reichle, Lippert, & Yoder, 1986). The use of the early communication skills training may be concurrent with consideration of augmentative options and communicative needs, but communication systems should not be assessed or applied until the users have developed sufficient skills to understand and use them.

The manual provides a detailed framework for issues to consider in communication system evaluation and intervention (Section III). Readers may wish to skip the general augmentative overview (Section II) if familiar with characteristics of systems. Many of these features will be covered in more detail in the assessment section as they affect the decision process. Short references for sources of further information are provided after each subsection, and the longer citation is listed in the reference list at the back of the manual. Equipment descriptions and product information on relevant products for communication systems are also provided in Section V.

SECTION II

GENERAL AUGMENTATIVE COMMUNICATION OVERVIEW

Augmentative communication refers to systems used to supplement the communication skills of individuals for whom speech is temporarily or permanently inadequate to meet communication needs. These individuals are considered nonspeaking if their speech is not adequate alone for communication, but most nonspeaking individuals make use of some speech, gestures, nonverbal behaviors, vocalizations, or sounds to communicate. Thus, augmentative communication is intended to assist existing means of communication, not replace them.

Augmentative systems include both the types of unaided systems commonly used by persons with deaf-blindness (gesture systems, modified fingerspelling, total communication/signing) and aided systems, which involve some additional object or device as an aid. The aid may be as simple as a tactile picture board or a set of switches, or as complicated as an computer-based Braille output system. Characteristics of augmentative communication systems can be broken roughly into four categories: type of aid (electronic or nonelectronic), input technique, content (symbol set and vocabulary), and output technique.

A. Type of Aid

1. Unaided Augmentative Communication Systems

The term unaided indicates that a system does not require any physical item for communication. Usually, this means that communication is conducted by some gestural behavior between the system user and receiver. For nondisabled persons, speaking is the most obvious unaided system. For persons with deaf-blindness, various procedures have been devised to bypass the limitations in hearing and seeing the information transmitted.

Advantages of these systems are portability and flexibility, since they do not rely on physical objects to convey information. In some cases, they may be conceptually simple and closely related to the ideas being represented. Most are unrestricted in vocabulary and can be adapted or selected to suit the needs of the users. The more formal the system, the more likely that an unfamiliar user may be able to understand and communicate using the same system.

Disadvantages of unaided systems involve the relative burden of communication placed on the listener and speaker. The extent of the speaker's vocabulary relies almost entirely on memory of the communicative behaviors, without any reference or self-prompting from a permanent display. Also, the listener must be familiar with the system as well as the speaker's

patterns of use, and only a limited percentage of the general population knows any nonspeech communication system.

For the user with deaf-blindness, traditional sign systems may create additional difficulties, both in sending and receiving messages. Signing very close to listeners with deaf-blindness to make use of their residual vision may complicate their visual field problems, and signs may have to be reduced in both scope and rate. This can interfere with the comprehension of the sign as a unified whole, and limit the potential channels of meaning transmission (i.e. it is difficult to tactually perceive signs coded in the hands, fingers, face, and body postion at the same time). Also, the visual iconicity of many sign or gestural systems may be of little benefit with deaf-blindness in learning or remembering signs; as a result, gestural systems may be less concrete and thus more complex for a speaker with deaf-blindness than one with deafness only.

The following lists and briefly defines different unaided systems used with deaf-blindness. A summary of the different systems is provided in Appendix 1.

Formal sign languages and systems. These are visual representations of concepts using body parts, particularly the hands and arms, which are organized according to structural or grammatical rules. American Sign Language (ASL) is a unique language with its own syntactic, semantic, and pragmatic rules, and has historically been used as the primary mode of communication for persons with deafness in the U.S. Other formal sign systems may have many signs and structures in common with ASL, but have been adapted to include English morphology, syntax, and vocabulary to faciliate acquisition of oral and written English. These pedagogical systems include Paget-Gorman Systematic Sign (PGSS), Signing Exact English (SEE2), Seeing Exact English (SEE1), and Linguistics of Visual English (LOVE).

Other formal methods used with hearing or vocally disabled persons can be modified for persons with deaf-blindness. Fingerspelling, or Manual English, can be tactually read by persons with deaf-blindness by placing their hand over the speller's hand. For people who have lost their vision after learning to read, palmwriting the shapes of the letters on the receiver's hand may be a means to communicate. Another signal system known as cross code indicates the alphabet by the relative position on the back of the receiver's hand. Similarly, for blind persons who later lose their hearing, Braille hand speech is possible; the receiver places the first three fingers of each hand together in the position of a Braille cell, and the sender spells out Braille letters and symbols using the fingers of that "cell". All of these methods rely on good spelling, English, and memory skills, and as such would not be appropriate for low level users.

Gestural Codes. Gestural codes have no grammatical or structural rules, but instead use demonstrative gestures such as pointing and descriptors that imitate an object's movement or

shape. Many gestures derive from emotional or visual qualities of a concept, and are closely tied to the meaning expressed. These systems are said to be easier to learn, particularly for mentally retarded users, because they are simple in structure and can be learned with less training than more formal systems. Examples of gestural codes are pantomime, Amer-Ind (Skelly, 1979), and natural gestures. Gestural codes tend to be the most frequently used system with deaf-blind persons (Jensema, 1981; Matas, Mathy-Laikko, Beukelman, & Legresley, 1985).

For more information, see:

Allaire & Miller, 1983

Jensema, 1979a, 1979b, 1980

Lloyd & Daniloff, 1983

Musselwhite & St. Louis, 1982

2. Aided Communication Systems

Nonelectronic Aids. Nonelectronic aids are any physical items used to help the communication process, including simple communication boards, books, or cards. They most often display a set of pictures, words, letters, or symbols that persons use in communicative interactions. Nonelectronic aids have several advantages over more complex electronic aids: a) they are relatively cheap and easy to construct, b) they are adaptable to changing needs of individual users, and c) they allow flexible use of different symbols in varying formats and settings (including different boards for different topics or purposes). Disadvantages of nonelectronic aids include the permanent nature of items on the boards or cards (they cannot be instantly adapted as needed in the way an LCD screen can) and the transient nature of indicating communicative output (as a speaker points to each item, the listener must remember the whole message without seeing it complete). Often, this requires considerable language ability and attention for the listener. However, this required close attention often increases the interactiveness of the system because the listener has a direct role in the message construction process.

Nonelectronic aids for individuals with deaf-blindness typically involve some tactile representation of communication items. For instance, in the Glove Method, the deaf-blind person wears a set of gloves with the alphabet and numbers printed on the back of both hands, allowing the nondisabled speaker to communicate by pointing to the letters with very little prior training. For communication boards/cards, items are either directly displayed in a recognizable form (e.g. raised line drawings, enlarged pictures, or physical objects) or coded in a consistent format with optional tactile cues (e.g. a row of tactile or numbered cards that represent different

concepts in combination - see encoding under symbol systems for more examples). The number and layout of the items on the board depend on the cognitive, sensory, and language skills of the user and receiver.

For more information, see:

Andrews, 1985

Blackstone, 1986

Bowe, 1984

Hinton & Ayres, 1987

Klima & Bellugi, 1979

Mcdonald, 1980

Moores, 1980

Rowland & Schweigert, 1982

Silverman, 1980

Electronic Aids. Electronic aids consist of four parts: a means to control or activate the device (input mechanism), a means to present information to the user (display/symbol system), some means of communicating the message to a listener (output mode), and electronics to enable and coordinate all of the above. In contrast, nonelectronic aids have the same components of input, display, and output, but the listener and speaker must coordinate the message between them without electronic assistance. Also, for nonelectronic aids, the input or output method may be a single behavior (such as pointing to a symbol) rather than a specific aspect of the device. Each of these components can be adapted to meet an individual's needs.

The control electronics provide the capability for memory control, program design, and message planning in an electronic aid. Some aids such as a typewriter simply transmit the message indicated by the user with no modification at all. Other aids provide means for retrieval of previously coded messages. These vary from aids that are preprogrammed by the manufacturer to aids that can be individually programmed by the user.

Electronic aids also vary in the extent to which they can be modified for different purposes. Many communication aids are termed "dedicated"; that is, they are created to suppliment communication with limited kinds of programs, and cannot be changed to fulfil other functions (such as word processing). On the other hand, computerized aids can be used for multiple purposes, and can be reprogrammed to function in different ways. In fact, the same computer

system (such as the portable Epson HX-20) can be an entirely different type of communication aid, depending on what software program is utilized.

Because electronic aids can be operated by a wide variety of input devices (from simple switches to complex keyboards) they can be operated by persons with severe motor or sensory problems. They also have the potential to adapt the type of display, input requirements, communication program, or assistance provided to the user. Unfortunately, they are relatively costly, less portable, and more complex to operate and maintain than nonelectronic aids. Furthermore, they need a power source to operate and may require ongoing service from a professional expert or manufacturer.

See Section V for listings of electronic aids and manufacturers.

For more information, see:

Allaire & Miller, 1983

Bernstein, 1988

Blackstone, 1986

Harris & Vanderheiden, 1980

Musselwhite & St. Louis, 1982

Vanderheiden & Lloyd, 1986

B. Input Mechanisms

The input mechanism can be described by the type of equipment (such as joystick, keyboard, light pointer) and the technique used to control the aid using the available equipment (primarily direct selection or scanning, with or without encoding). Different types of equipment can be used to operate the same computer with different selection techniques. Also, a person may use multiple input mechanisms (such as a keyboard, single switch, and additional nonverbal body movements) to complete a message using a single communicative system. Some input mechanisms are better suited for certain disabilities or functions than others.

Equipment. Different types of input devices differ primarily by the type of movement used to operate the computer and the aids that the client uses to make that movement. For instance, standard keyboards are operated by pressing different keys from a keyboard. If the person is unable to use the hands to operate this device, then other parts of the body may operate the keyboard with aids like mouthsticks, headsticks, or foot-operated controls. If a keyboard is too complex (motorically, visually or conceptually) or otherwise inappropriate, then a wide variety

of devices that use other movements (like eyegaze, lightpointing, muscle action) or movement patterns (like touchscreens, joysticks, switches, expanded keyboards) may be recommended. If the input device is different from a standard keyboard, most computer systems require some device to make the new input equipment seem like a keyboard to the system (called a keyboard emulator). For more detailed information on input equipment for communication devices, see Brandenburg, Bengston, & Vanderheiden, 1986, and Vanderheiden & Lloyd, 1986.

Technique. There are two major techniques that can be used to select message elements using augmentative communication systems: direct selection and scanning. Direct selection requires the user to directly indicate the message by pointing or pushing (e.g. finger, fist, head, eyes, light beam, mouse). Equipment such as a keyboard, mouse, joystick, or light pointer is most often used with in direct selection. When motor abilities are sufficient, direct selection is the most common, efficient, and rapid message selection technique.

Scanning is a technique that uses a limited movement or reaction to select from a larger set of selections presented to the person one at a time. This is very useful if a person has to use a simple input device (like a switch) to do a complicated task (like communicate a variety of messages). In simple scanning, the system displays or speaks the available options one at a time and the user means to activates a switch (or other input device) when the desired choice is reached. More complex scanning can use elaborate systems for narrowing down a large number of choices quickly, like scanning topic areas first, then branching off to increasingly detailed choices to reach a specific message. In general, scanning is a more cognitively difficult task than direct selection because the choice-making is more indirect and requires waiting until the appropriate choice is presented before acting. Any of the methods of scanning can also be used nonelectronically with a listener presenting the choices verbally and the user indicating yes or no, but this places a great importance on the capabilities and patience of the listener.

One technique to speed up choices with either direct selection or scanning is called encoding. With encoding, a short sequence of choices is associated with a more complex message by a predetermined code. This can be as simple as a listener knowing that a certain sequence of behaviors always indicates the same message, or as complex as using Morse code or arbitrary number codes to indicate a particular message. Use of encoding tends to require not only the cognitive and motor skills to understand the process, but sequencing, memory, and message planning skills to remember the specific procedure.

For more information, see:

Vanderheiden, 1981, 1982, 1984

VanTatenhove, 1984

C. Content (Symbol Set and Vocabulary)

Since the primary purpose of a communication system is to communicate an idea, or content, the system must have a way to represent those ideas for the client to use. Verbal/written language is the most obvious means for representing ideas, but this requires the ability to translate the linguistic symbols of language (letters/words, Braille, or Morse Code) into ideas. Some clients need to use symbols in their communication systems to either suppliment or replace the use of linguistic codes. These symbols may be arbitrary (like the 3-dimensional Premack tokens, in Premack & Premack, 1974) or closely linked to the standard linguistic systems like the International Teaching Alphabet (see Musselwhite & St. Louis, 1982). Other symbols may directly resemble the objects they represent, with miniature objects, pictures, photographs, drawings, or specially designed symbols. Some systems, like Blissymbols, Rebus, Picsyms, Pictogram Ideogram Communication (PIC) or Mayer-Johnson PCS have combinations of arbitrary and more representational symbols, designed to represent as clearly as possible a range of concepts that may be difficult to show in a picture. In some cases, symbol systems may consist of actual objects or pieces of objects, as in many tactile representation systems, to symbolize a larger concept or action.

With any symbol set on any communication aid, a crucial decision is determining what vocabulary will be represented on the system (in other words, what ideas should be conveyed with this system). This is an important decision for all communication systems, but central to the design of systems for persons who cannot add to their communication vocabulary by themselves (e.g. by spelling new words). Choice of vocabulary systems must take into account a variety of factors such as communication opportunities, environments, partners, topics, and client preference, and will be discussed in more detail in section III.

For more information, see:

Beukelmen, Yorkston, & Dowden, 1985

Carlson, 1985

Clark & Woodcock, 1976

Johnson, 1980

Maharaj, 1980

McNaughton & Kates, 1980

Silverman, McNaughton, & Kates, 1978

Wilbur, 1980

Zuckerman, 1983

D. Output Technique

The output technique is of particular concern to persons with deaf-blindness, since traditional means of visual, auditory, and written presentation of information are often inappropriate. For the nondisabled computer user, information is usually conveyed to the user by visual means, on a computer screen, small LCD display on a device, or in printed "hard copy" form. For visually impaired users, typical means of replacing visual information with auditory substitutes are insufficient for persons with deaf-blindness without residual hearing. Braille output is a common output mode for computer users with deaf-blindness, but this requires good reading and cognitive skills as well as intact tactile sensation, and is largely inappropriate for persons requiring picture/object based communication. Some new techniques for output by mechanical fingerspelling with an artificial hand are available, but electronic output using tactile nonlinguistic symbols have not yet been developed. Many electronic and nonelectronic aids may be used by persons with deaf-blindness to send information to a listener, but often the success of communication of a message depends on listener response rather than direct feedback from the output device.

For more information, see:

Beeson, 1981

Beukelman, Traynor, Poblete, & Warren, 1984

Goodrich, 1984

Hobbis & Williams, 1986

Kruger, 1979

Shane, Ferrier, Tolwin, & Sauer, 1985

Thurlow, 1986

Young, 1984

SECTION III

DECISION PROCESS FOR AUGMENTATIVE COMMUNICATION EVALUATIONS FOR PERSONS WITH DEAF-BLINDNESS

The following section is an application of a general decision making process for developing and selecting augmentative communication systems for nonspeaking individuals (Yoder & DePape, 1988). The overall outline of the process is provided in Figure 2. For each stage of the process, the manual will discuss general issues that arise for nonspeaking individuals and apply these concerns to the specific needs of deaf-blind persons. Additional resources for further information, materials, explanations, and critiques will be provided at each stage. Issues addressing the application of both nonelectronic and electronic communication aids will be considered, with particular emphasis on aided communication.

I. Assess Communicative Needs

The first, and most important stage in developing a communication system is to determine the person's communicative needs. In what situations does s/he need to communicate, for what kinds of messages and functions, and with what kinds of restrictions in environment and user characteristics does communication take place? The conclusions drawn from the initial needs assessment are continually re-evaluated and adapted throughout the evaluation process, since a change in a client's skills or environment may drastically alter the type of communication system that is appropriate.

Several methods are used for gathering the information for a needs assessment of communication. A good communicative history from caretakers and rehabilitation personnel familiar with the client can provide a profile of a client's patterns of interaction before beginning formal assessment. A communicative diary can be used, in which the primary caretakers record the client's communication situations, partners, topics, and purposes, means and success of interactions during a given period of time. It is important in these types of samples to record not only what types of interactions occurred, but in what situations communication seemed to be appropriate or necessary but did not occur, and what barriers interfered with potential communication. Some roleplaying or trial interactions may be conducted to sample communication behaviors in situations that may be infrequent but important for a given client (perhaps communication with strangers). Direct discussion and observation with the client and caretakers are essential, to guard against premature assumptions of what <u>should</u> be communicative needs rather than what <u>are</u> current communicative needs. It is essential, however, to consider how a person's communicative needs will change over time, so that a system can be adapted to meet both present and future needs.

Communicative need assessments should cover the following basic topic areas: with whom does the client interact, where does communication take place, what types of messages does the client most often wish to convey, what kinds of communicative interactions and methods are involved, how do the client's messages fit into turntaking situations with other listeners, and how successful is the client at conveying messages with different functions? For each of these topics, the following sections will review factors to consider both in general and in specific for persons with deaf-blindness.

For more information, see:

Currin & Rowland, 1985

McDonald, 1980

Musselwhite & St. Louis, 1982

Shane, 1980, 1986

Yoder, 1980

Yorkston & Karlan, 1986

A. WHO: With whom does the client interact or need to interact?

Persons: Family/caretakers, friends/peers, strangers, rehabilitation personnel, teachers, employers/colleagues,

Factors to consider: how much time is spent with each person, what age, how familiar are the interactants with the system and speaker, how many people are listening at once, what types of skills/limitations do the listeners have, how will potential interactants change over time,

The extent of a person's social contacts and the willingness of persons in the environment to adapt to difficult communication requirements will have a major effect on the type of system practical for that client. Some systems, such as sign language or unaided scanning systems require extensive knowledge and time commitment from all persons interacting with that client. This may be acceptable if the client's existing and desired communication partners are limited to those familiar with the system, but are likely to be inappropriate if the client interacts with many unfamiliar listeners. Other systems may be easy to use for the listeners but require extensive time commitments from caretakers and service personnel to establish and maintain the system (such as Minspeak or other complicated encoding methods). Also, some systems may be unacceptable to some categories of listeners because of limitations in skills. For instance, young children are a particularly difficult listener category because of poor reading skills and limited ability to understand most synthesized speech. Other factors that may affect a listener's ability to interact with a speaker include poor vision/hearing (which affect their ability to access the

system output), limited familiarity with the system or willingness to learn, poor language skills, or limited patience with slow or incomplete messages.

For persons with deaf-blindness, a combination of systems may be the most appropriate for use with different listeners. Family and service personnel may be capable of interacting using an unaided interactive system such as fingerspelling or signs. For unfamiliar listeners, a topical communication board (perhaps with tactile cues) may be sufficient for communicating a limited range of messages in public settings.

B. WHERE: in what settings does the speaker communicate

Places/Activities: Home, school, work, hospital, community, recreation, church, car, moving from place to place (bed, wheelchair, walker, public transportation)

Factors to Consider: how much time is spent in these places, what topics and activities are common, what are space and time limitations in the settings, what other materials are available, what position is the client in for most of the time, how will places/activities of communication change over time

The different settings for communication affect the types of topics and activities expected for the speaker. If a speaker only can access a few messages at any given time, those messages can be tailored to different communicative settings if there are situation-specific communication needs that can be identified. Information about communicative settings is particularly important for vocabulary selection for communication aids, since a thorough analysis of amount of time spent in different settings will influence the relative importance of different vocabulary items in a system. For instance, a symbol for "homework" may be of little use if school is not a frequent activity, or if all work is actually completed at school.

The amount of shifting between settings is an important consideration for decisions about the type of aid selected. For instance, a large, elaborate communication board may be the best system for a home setting, but impossible to transport. Portable systems may have to withstand adverse conditions in transport such as spills, rain, and mishandling. Also, a speaker may be in primarily one position at home (perhaps lying down, reclining, or sidelying) while in a different position for outside activities (such as sitting upright, standing, or walking). Considerations such as accessibility of power sources and weight of a system may also affect the practicality of electronic systems.

Some of the current available aids specific to deaf-blindness tend to be rather bulky, and more suitable for limited locations. For instance, systems using parts of real objects as cues are often difficult to transport. Since these systems are often developed from objects in the immediate environment, there is the possibility for individualized systems specific to different

settings. Many of the innovations developed in portable Braille aids make a transportable aid much more practical, if the speaker uses a linguistically coded system.

C. WHAT MESSAGES: what needs affect what the speaker wishes to express

Types of Needs: Physical needs, emotional needs, social interaction, creative needs, informational needs,

Factors to Consider: Emergency situations, frequency of interactions, preferred topics/interests, means for expressing feelings vs. information, ways to facilitate creativity and independence, how might these change in the future

The most immediate needs that occur to most service personnel and caretakers when anticipating communicative needs are emergency concerns, primarily physical ones. These include hunger, pain, toileting, need for change in position or situation, safety, and security. Other high frequency message types on communication devices are indications of emotions or reactions to activities (e.g. I'm angry). These types of emergency messages should always be available to the speaker if at all possible. While these are of central importance to accurately convey, both for speaker and listener, it is important to consider the less tangible needs of a speaker, such as social interaction or information requests. A communicative area often overlooked in designing systems is creativity, including humor, playing with ideas, daydreaming, expressing opinions or artistic creation.

Particularly with deaf-blindness, it may be necessary to speculate about what types of functions may be needed if the speaker had more complete communication systems. Many communication systems based on direct representation of messages are difficult to adapt for creativity or emotional expression. Often, a speaker will have multiple verbal and nonverbal means for expressing different kinds of needs; for instance, facial expressions can signal certain emotions, and nonverbal emphasis or pointing can modify the meaning of a given message. A more complex communication system may be a means of elaborating on more direct means of expression of needs.

D. HOW: what types of communicative modalities or methods are used

Types of Modalities: verbal communication, both private and public (large/small groups, formal/informal), nonverbal communication, telephones, writing or drawing, computer access

Factors to Consider: face-to-face vs. distant communication, messages, educational or vocational tasks, number of people receiving the same message, permanence of information conveyed, time constraints on expression, accessibility of materials, how can these change in the future

Different communication modalities place a variety of demands on a communication system. Face-to-face interaction can utilize pictures, nonverbal, and behavioral signals, while

telephone or written communication tends to rely more heavily on the verbal message. If many people must receive the same message, as when talking to a group, then the output of the system will need to be visible or audible on a large scale. Many communication settings that require a permanent record of communication rely on written communication, since verbal or behavioral communication is highly transient. Specialized writing such as mathematics, drawing, or educational tasks will require more detailed symbol systems than personal writing such as lists or notes. Computer access can be both a means of communication, and a task necessary to complete for its own sake (e.g. for educational or vocational activities).

For persons with deaf-blindness, some settings or modalities of communication may be very limited. If the speaker does not either know Braille or have access to electronic computer systems compatible with a TTY, telephone communication will be difficult. Many pictoral systems use relatively small symbols and pictures, which may only be suitable in face-to-face communication. If tactile nonaided communication is used, communication input from only one listener at a time will be possible. Again, it is important to note communicative needs even if it seems that it is impossible to meet them, because a communication system is only acceptable and successful to the extent that it meets all current and desired communicative needs.

E. WHAT FUNCTIONS: how does the speaker's communication fit into turntaking situations

Communicative Functions: requesting, calling, protesting, greeting, labeling, answering, repeating, informing, practicing, teasing, correcting

Factors to Consider: how often does the speaker intiate, reply or correct a message with these functions, how successful is the speaker at conveying their intended meaning, how do different communicative partners repair communication breakdowns, how is this need likely to change in the future

When a nonspeaking person is interacting with a nondisabled speaker, the unimpaired speaker tends to take more of the role of initiating and structuring an interaction. This is a particular concern for deaf/blind individuals, since most of turntaking for other speakers is coordinated with nonverbal signals, including body movements, facial expressions, and changes in voice quality and stress. While a nondisabled speaker may be able to read these cues to allow time for the other speaker's turn, a speaker with deaf-blindness will have difficulty interrupting, correcting, or planning communication relative to another speaker's speech or activity. One common result of this imbalance is that nonspeaking individuals tend to be asked many questions, and respond to rather than initiate communication. An important function of a communication needs assessment would be to determine in what settings or conditions this is a particular problem, and what types of compensation the speaker makes to express their message. Other areas of particular focus would include communicative functions or strategies that are particularly successful, to build on existing systems in developing an augmented system.

II. Assess the Current Communication System

Once the communicative needs have been explored, the next step before beginning to develop communication systems is to describe the client's existing communication system. This evaluation is often done in similar ways to the communication needs assessment: by interview, survey, behavior sampling, and roleplaying. The primary question for all clients throughout this process is how do they give and receive communicative signals to fulfil functions within an interaction?

Part of evaluating a speaker's communicative system is assessing the separate skills that influence communication. For instance, what physical movements are possible/reliable, and what positions seem to facilitate movement the most? For deaf-blind individuals, a thorough evaluation of residual vision and hearing is essential, since assessment is often difficult for this population. In particular, attention should be paid to different responses to various types of auditory and visual information, as well as absolute acuity alone. For instance, a client may respond to moving but not stationary light, or might react negatively to loud high pitches but not low pitches. Other particular concerns for deaf-blindness include tactile skills, such as ability to recognize shapes and sensitivity to variations in objects or symbols.

If clients have sufficient verbal or symbolic communication, a vocabulary and function description is useful for evaluating effectiveness of communication. For instance, it is important to know not only that a client knows 50 signs, but also whether those signs include a variety of functional situations or represent only highly desirable activities and objects. Concepts already represented within a client's vocabulary may also be an indirect means of assessing the cognitive/linguistic status. Additional vocabulary development is focused on facilitating communication in the settings identified in the needs analysis.

Potential channels of communication can be either verbal or nonverbal, including vocalizations, behaviors, signs, and gestures. Most communication is conducted by a combination of verbal and/or nonverbal communication, depending on user skills. Many types of natural nonsymbolic behaviors can be early means of signalling communicative intent. For instance, at an early cognitive level, turning the head away and pushing an undesired object is a natural way of communicating dislike or negation. As communication skills develop, this signal may generalize into a "no" behavior or vocal approximation. Similar types of functional movements can develop into more formal symbolic gestures such as requests for objects or actions.

For clients with little or no verbal communication, most information about cognitive/language skills is gathered from early communicative intents. For instance, how does

the client indicate yes/no, refusal of something, a request or choice, a wish for attention, questions or pleasure? How do caretakers interpret emotions, preferences, and intents? Also, a crucial concern for developing more formal communication systems is the degree to which the client is motivated to interact with other people or is willing to accept modifications in their current way of communicating. An augmentative system can facilitate the means of communication, but cannot substitute for the incentive and content of communicative interactions.

If potential candidates for communication systems are not yet producing basic communicative functions, these skills should be developed before attempting to apply augmentative communication. All communication is based on interaction patterns, and since a communication system adds to existing difficulty of interaction, a client must have reliable skills at expressing intent and maintaining interactions. For clients who are not expressing these communicative prerequisites in interaction through symbolic or nonverbal means, a complete protocol for assessing and training communicative prerequisites is provided in the Early Communication Skills Curriculum (Higginbotham, et al., 1986). Target goals for this curriculum should be assessed for any client for whom communicative prerequisites are unclear or incomplete. Following successful acquisition of these early skills, the client's communication system should be re-evaluated to see if augmentation is now appropriate.

Another possible decision at this stage of evaluation is that the current communication system is adequate for the speaker's needs in their communication environments. Primary factors which affect this decision are acceptability for the persons involved and sufficiency of communication for interaction needs. These criteria are re-evaluated throughout the assessment process, to avoid making decisions which are practical in the short run, but do not meet the long-range goals of communication for a client. If a given system is deemed acceptable by the assessment team, clients, and caretakers, then the assessment process jumps to follow-up, to ensure that changing needs are still met by the system.

For more information, see:

Coleman, Cook, & Meyers, 1980

Kahn, 1975, 1983, 1984

Owens & House, 1984

Reichle & Karlan, 1985

Shane & Bashir, 1980

Yorkston & Karlan, 1986

III. Describe Limitations of Current Communication System

Assuming that the client's communication system is not fully adequate for their needs, but that s/he has demonstrated sufficient communicative prerequisites for interaction, the next step is to more fully describe the specific limitations of the system. This is accomplished by matching the communicative needs gathered in step one to the characteristics of the existing system from step two of the decision process. For instance, a client may need to be able to interact with peers in a school setting, but does not produce communicative output that they can understand because the other students are deaf and blind. Limitations of this current system might include insufficient tactile or behavioral output, environmental constraints on acceptable communication settings, and incomplete feedback for the speaker on success of communicative output with peers.

Areas for description of limitations in the current system parallel topics for potential changes in the system: user skills, tools/methods, environment, acceptance of the system, and use of the system in communicative interactions. Some of the reasons for limitations in acceptability or interaction may overlap with more general limitations of components of the system. For instance, a user may not like fingerspelling as a communication because of limitations in the numbers of persons in their environment who are willing to learn the system. Limitations may not always be resolvable, particularly limitations of speed and range of accessible vocabulary, since these considerations tend to counterbalance each other; if a client has a large vocabulary, it is usually slower and harder to access. It is necessary to weigh relative benefits and limitations of a communication system to determine if the existing system can be maintained and changed, or must be completely revised to overcome problems.

For more information, see:

Behrmann & Lahm, 1983

Hicks, 1979

Schuler, 1985

Silverman, 1980

Yoder, 1980

Yoder & DePape, 1988

IV. Evaluate Potential Changes in the Communication System

Once the limitations of the current system have been identified and roughly prioritized, the next step is to explore the client's response to possible changes in their communication system. As much as possible, it is helpful to examine changes in small steps, so that changes in behavior can be associated with changes in the system. For instance, a sudden change from picture-based to word based communication may be unsuccessful, for a variety of reasons ranging from visual acuity to symbolic representation to limitations in producing understandable verbal messages.

Since human behavior is rarely predictable beyond short range activities, it is necessary to evaluate the possible success of modifications to a communication system before investing time and effort in intervention techniques. Even such a seemingly simple choice as selecting a single switch to be operated by the hand can be a time-consuming and complex decision, considering all of the different types of movements, sensations, and decisions involved in using that switch for a purpose. Although many improvements may not be apparent without more extensive training, a brief trial of potential communication techniques is an ideal way to both test appropriateness of a system and model procedures for clients and caretakers.

The following sections outline some considerations for system concerns and examples of changes with persons with deaf-blindness. The examples provided are not necessarily recommendations of techniques for any given client, but only illustrations of a more general topic area. Note that most changes in "system" are modifications and improvements in existing communication methods. Augmentative communication may be as simple as providing visual or conceptual cues to clarify behavioral communication techniques.

A. User Skills

In general, changes in user skills are accomplished by training users directly, modelling appropriate behaviors to encourage for caretakers and interactants, counseling, experiential learning, or behavior modification. Some skills may be beyond the control of the therapist, or vary greatly between sessions. Others, like motivation, may be indirectly addressed by modifying situational expectations or relative success at desired activities.

1. Physical Skills. Except for persons with multiple disabilities, physical skills tend to be less limited for persons with deaf-blindness than other nonspeaking persons. The primary avenue of change in physical skills tends to focus on development of tactile skills. Appendix 3 outlines a sequence of development of tactile behaviors and their associated skills. More detailed information on facilitating tactile development is provided in Hart & Spelman (1989). Further

details on motor abilities as related to communication systems is covered under "Tools - Motor Requirements".

2. Sensory skills. If functional use can be made of residual vision and hearing, then more flexibility of communicative output is possible. Acuity in hearing or vision may be improveable by correction, although performance is likely to change over time or with age. Most training methods concentrate on making the best use of skills remaining, as in using residual hearing to facilitate comprehension of verbal communication (even if only to detect paralinguistic variation in the speech signal). Details about visual or auditory performance are important for tailoring sensory input to signals that are meaningful to the system user. For instance, computer feedback that is transmitted through a beep or brief flash on the screen can be adapted to a particular frequency or pattern recognizable to the user, to signal important changes in information transmission.

For more information, see:

Cress, 1989

Spradlin, 1989

3. Cognitive Abilities. A sensorimotor stage VI has been considered by some investigators to be a prerequisite for electing to implement an assistive communication device (Chapman & Miller, 1980). However, valid cognitive assessment is very difficult for children with sensory impairments, and many of the standardized measurements of intellectual level are inappropriate. Information from observational assessments and parent reports may assist in determining the child's level of cognitive functioning.

Many training programs for persons with low cognitive skills concentrate on memory, problem solving, or basic functional tasks to improve communicative skills. For instance, while means/end behavior is a commonly stated prerequisite for understanding the use of assistive communication systems, associations between actions and reactions can be improved with practice in programs where the user either causes or reacts to a consistent stimulus (as in many cause/effect software games). For deaf-blind persons, this type of training is more commonly conducted as functional activities, such as switch toys or selection of activities.

For more information, see:

Buzolich, 1986

Dunst, 1981

Fewell, 1983

Meyers, 1984

Rogow, 1982, 1984

4. Speech and Vocal Skills. While most children and adults are considered for assistive communication because of severe difficulties with speech, some type of vocal communication may be appropriate in combination with other methods. Vocalizations can serve as attention signals, emotional expressions, emphasis, or simple messages without necessitating highly differentiated vocal patterns. Intervention may involve increasing the coordination of verbal output with other assistive communication methods. The persistence of primitive oral reflexes is likely to interfere with the functional use of speech or vocalizations as a meaningful signal. Children with deaf-blindness may receive little feedback from vocal signals, and may require ongoing monitoring and training to maintain these as deliberate communication.

For more information, see:

Kahn, 1984

Musselwhite & St. Louis, 1982

Reich, 1978

5. Language Knowledge. The flexibility and specificity of communication often depends upon the vocabulary available to the speaker to express communicative needs. Many therapy programs concentrate on increasing knowledge of situation-appropriate words, signs, or symbols available for communication. This may be accomplished by drilling specific vocabulary, providing focused language activities around a desired topic area, or increasing language exposure and stimulation in communication environments. For instance, it is often helpful for children with deaf-blindness to tactually label objects and associated concepts even if those items are not used directly in therapeutic or functional activities. This can provide wider exposure to unfamiliar vocabulary, and broaden the receptive language model. As language knowledge changes, vocabulary selection for the communication system can adapt to better address communication needs.

For more information, see:

Bryen & Joyce, 1985

Harris & Vanderheiden, 1980

Kraat, 1985

Locke & Mirenda, 1988

6. Health Process. This is a particular concern if any of the causes of deafness or blindness are variable or progressive. Poor health in general can affect attention, receptiveness to intervention, and fatigue with communication and learning tasks. Anticipated changes in health status must be considered in developing other physical, sensory, and cognitive aspects of communication systems.

7. Acceptance. Usefulness of a communication system is highly dependent on how acceptable that system is to the user. While rehabilitation personnel attempt to anticipate what will be acceptable by sampling communication needs and building on existing systems, users may judge a communication system by factors other than effectiveness alone (such as attractiveness, ease of learning, flexibility, or various preferences of system use). Acceptability often varies with system familiarity, so it may be necessary to present trial periods with different system variables in order to determine acceptability. Also, since user opinions are likely to change with changing skills and opportunities, it is important to reassess user acceptance of a system throughout the evaluation and training process.

8. Motivation. Motivation to use a particular communication system is associated with willingness to engage in interactions, motivation to communicate a message, and willingness to learn and use a particular system for sending and receiving messages. Motivation can also vary with environments, topics, listeners, messages, experience, or personal factors (ability, emotions, mood). If a client is reluctant to initiate or engage in interactions without a communication system, introduction of a new system alone is usually insufficient to change interaction patterns without specific interaction training. Many children with deaf-blindness may have poor motivation for using a communication system because of limited experience with communicative interactions.

9. Interests/Experience. Often, rehabilitation personnel develop communication systems based on information that they would like to receive from the client, such as personal care, hunger, or pain signals. While these types of communications are often necessary in emergency situations, they may not be of interest to the client for daily communicative interactions. Extent of client involvement in using a communication system is associated with how much the system helps them to communicate about or do something of interest to them. This is one of many reasons why a thorough communication needs assessment is important for system development throughout the entire process. As a client ages, interests and experiences are likely to change and require revisions in early versions of a system.

B. Tools/System

1. Type of system. Many of the same techniques can be used with electronic or nonelectronic systems. For instance, picture or word selection can be made using a pointing board or computer, depending on the skills and requirements for the user. Unaided systems such as sign language tend to require highly skilled listeners and face-to-face interaction. Aided systems depend on the availability and reliability of equipment and ability to produce and receive appropriate signals. For the user with deaf-blindness, different types of systems are often used in different situations. For instance, unaided signing may be used with familiar listeners for social communication, tactile symbol boards for functional or emergency communication, and computer-based systems for novel or educational communication.

For more information, see:

Kraat, 1980

Mirenda, 1985

Musselwhite & St. Louis, 1982

Shane & Bashir, 1980

Vanderheiden, 1981, 1983, 1984

2. Positioning. Whenever possible, it is important to consult the occupational therapist and seating and positioning specialist to obtain the best positioning and seating system for the client. It is of critical importance to assess the position and seating posture of the client to assure the most reliable placement for switch control access. Poor posture can interfere with breathing, eating, comfort, lead to deformity, and limit the client's control over the augmentative communication device as well as limit other functional activities. Positioning will differ across activities, whether the person will be interacting while lying, standing, sitting, moving, or sidelying. For persons with severe physical involvement, changes in positioning can make astonishing differences in attention span, interactiveness, and motivation to communicate, because less work is spent in keeping body parts controllable or keeping the head and eyes focused on a task. Even for less severely involved clients, positioning communication materials at an easily controllable level can decrease the amount of effort spent in the mechanics of communication.

For more information, see:

Bergen & Colangelo, 1982

Trefler, 1984

Ward, 1984

3. Motor requirements. The primary purpose of a motor assessment is to decide the best way for a client to signal communication or access an aid. This will vary from client to client depending on their individual motor and mental capabilities. Some types of decisions for electronic or aided systems include the location, body part, and switch selection for indicating a choice with the aid. These decisions are made as part of a complex assessment process by occupational therapists. For unaided communication, more elaborate sampling of changes in hand shape, range of motion, and coordination are among relevant concerns. Appendix 4 contains a screening protocol designed to sample movement behaviors relevant to the selection of movements for controlling communication systems.

For more information, see:

Finkely, 1988

Griffith & Robinson, 1980, 1984

Griffith, Robinson, & Pangos, 1983

Stowers, Altheide, & Shea, 1987

4. Input/Expression Options. Two overall methods are possible for the user to express a desired message. One is some sort of direct selection, either acting on or selecting a message by indicating that message directly. Types of direct selection for aided systems would include pointing in an object array, touching a tactile symbol, or typing a request with letters or other codes. For unaided systems, direct selection would include producing a sign directly connected to an idea, fingerspelling a desired action or object, or gesturing towards a desired object. In all of these cases, the speaker controls the selection of the desired message directly.

Another means of expressing a message involves scanning, where a device or listener presents possible choices and the speaker indicates which is desired. For aided systems, the choices are presented automatically in a predetermined pattern, and the user stops the system when the desired choice has been reached. For unaided systems, the listener presents possible options through whatever mutual communication channel is available, and the user signals (usually vocally or behaviorally) that a choice is correct. This involves more active negotiation between speaker and listener, and often is structured as a series of questions with implied "yes" or "no" answers.

Changes in the type of selection (direct or scanning) or the method of indicating the choice (voice, gesture, pointing, touching, using a switch or other device) may be considered if the

existing communication system is not adequate for conveying messages. For persons using primarily gestural or sign communication (which relies heavily on direct expression of messages by the user), it may be useful to consider adding an agreed-upon protocol for scanning possible messages in difficult situations. For persons using scanning systems (such as yes/no question asking), it is common to see a few behaviors or signals retained as direct expressions of emergency or high frequency messages.

The behavior or action selected as the means of input or expression in a communication system will depend on motor and cognitive skills as well as the type of behavior. Sign and systems use detailed and often elaborate hand/arm behaviors, while pointing boards require high controlled repetition of a single behavior. More elaborate electronic systems can utilize almost any type of movement as a signal to operate a communication device. The more motor control a person has, the more elaborate an input device he/she can operate (such as a keyboard, Braille typewriter, or multi-item selection board). Even motor responses as small as a muscle twitch, eye gaze, or head turn can operate switch devices for signalling communicative messages.

For persons with deaf-blindness, common input methods are behaviors (gestures, signs), touching a desired object, or selecting from an array of tactile symbols. Direct selection methods are usually faster and less cognitively difficult, and typically recommended unless motor skills are insufficient for multiple discrete motions. If the user has language skills advanced enough to spell, a keyboard or Braille typewriter is a way to signal a message with options for receiving correctable feedback (see output/reception). If the user has learned some type of code, such as Morse Code or Braille, a small number of movements or switches can translate into complex messages.

5. Symbol Systems. Symbol systems should be matched to the client's cognitive level and communicative goals. Typically, representative symbol systems are the simplest and easiest to learn, since the symbols have a close correspondence with the meanings they represent. Such symbol sets include miniature objects, pictures, photographs, representative portions of objects, as well as specially designed sybmols such as Rebus, Picsyms, Blissymbols, Pictogram Ideogram Communication (PIC) and Mayer-Johnson Picture Communication System (PCS). Some of these symbols can be displayed in a tactile form for persons with deaf-blindness, but the sets may differ in ease in distinguishing between symbols by touch alone. These types of systems have been recommended for many initial aided communication systems because they can be used with persons who cannot read, and tend to have a close association with salient objects in the environment. Some evidence (Mizuko, 1985) suggests that PCS symbols are easier to learn among the formal representational systems, followed by Picsyms and Blissymbolics.

Other more abstract symbol sets, such as Yerkish lexigrams (Rumbaugh, 1977) or Premack type tokens (Premack & Premack, 1974) are three dimensional and easily discriminated by tactual manipulation. The Premack tokens are designed to be used in the Non-Speech Language Initiation Program (NonSlip) (Carrier & Peak, 1975) which has been applied to persons with deaf-blindness. A disadvantage of these systems that interferes with their useability as a communication system is difficulty with display of symbols and portability. Also, these symbols are based on more arbitrary shapes, and are likely to require more time for learning.

Symbolic language codes require the highest level of cognitive functioning of the different symbol types. Traditional orthography is often selected for clients who have the cognitive and language prerequisites for learning reading and writing. Other forms of literal orthography, such as Braille or Morse code, may be preferrable for persons with sensory handicaps to increase user access to output of the system. Variations of traditional orthography such as the International Teaching Alphabet (i.t.a.) have been adapted to increase the association between English sounds and writing. This alphabet has a one-to-one sound-symbol correspondence, and has been used to facilitate reading and teach spelling skills to persons with cognitive disabilities (Musselwhite & St. Louis, 1982; Shane & Melrose, 1975).

Persons with deaf-blindness often initially use a more representative symbol set in early interactions. Pointing to a representative sample of an object or gesturing a salient feature of an object are early examples of symbolic representation. As cognitive and language skills develop, the symbol sets used may change to accomodate a larger vocabulary and variety of words.

For more information, see:

Carlson, 1985

Clark & Woodcock, 1976

Johnson, 1980

Maharaj, 1980

Silverman, McNaughton, & Kates, 1978

6. Vocabulary Selection. Because of the limited capacity of both a person's and a device's memory, careful selection of vocabulary used in a communication system is important. Determining the vocabulary content of the system should be based on the communicative needs identified at the beginning of the decision process, and take into account shifts in environment, topics, and potential interactants. For example, the vocabulary for an individual living in an

institution may be different from someone living at home due to differences in communication needs, partners, etc.

Suggestions for most frequently used vocabulary items by different types of users or for different situations may be helpful in structuring large vocabulary sets with high-level users. For system users who produce complete, standard English sentences, a relatively small number of words accounts for a large proportion of all words spoken by nondisabled speakers. Since these most common words (such as "and" and "the") are not particularly useful by themselves, including such words in a vocabulary set is only useful if the client is also able to spell out the less frequent but more content-based words without assistance.

The number of words/concepts useable by the client will affect how many new or limited-use words are on a vocabulary, since a communication system must make efficient use of both the client's learning capacity and the presentation format of the vocabulary selected. For persons with deaf-blindness, the most common word category included by most of the clients is nouns, both for signing and graphic symbols. These tend to be more common, both because they are easier to represent tactually, but also because they tend to be directly associated with choices of behaviors or objects. Client preference for topics and functions of communication should take precedence, since the primary function of the aid is to provide a means of self-expression and communication of needs, but additional vocabulary may be added to facilitate educational concerns. Often, vocabulary that is functional in a given setting is added to a board, even if the terms are unfamiliar to the user, as a means of modelling and teaching concepts just beyond the current cognitive level.

For more information, see:

Beukelman, Yorkston, & Dowden, 1985

Blau, 1983

Carlson, 1981

Cress, 1987

Goodenough-Trepagnier & Prather, 1981

7. Output/Reception Options. Since the visual and auditory modes are impaired for persons with deaf-blindness, the primary mode for communicative input is tactile communication. For persons able to read Braille, printed and electronic displays can present exact linguistic information to the user as soon as it is produced. In many of the specially adapted gesture systems, such as manual fingerspelling, movements that would usually be perceived visually are presented tactually. In situations of requesting an activity, the implicit communicative response

to a request is the beginning of that activity. Receptive communication using a communication board is possible during interaction between a listener and a user with deaf-blindness is possible by directing the user's hand to desired messages for them to receive or understand. It is possible for a nondisabled speaker to use a variety of methods to communicate with a disabled listener, even if the listener does not use all of those methods, provided that the signal is presented in an appropriate and comprehensible form.

For more information, see:

Beeson, 1981

Beukelman, Traynor, Poblete, & Warren, 1984

Fristoe & Lloyd, 1980

Locke & Mirenda, 1988

Mirenda, 1985

Shane & Melrose, 1975

8. Technical Limitations. If aided systems are used in communication, several technical modifications may be considered to add more flexibility or ease of use for the speaker. Features such as size of symbol display, arrangement of symbols, color/texture contrast, and type of representation may make distinguishing and recalling symbols easier. For electronic systems, issues such as portability, cost, battery duration, reliability, durability, ease of programming and modifying, and compatibility with other controls or systems are likely to be major concerns. If unaided systems are used, technical limitations are more general, such as skill of both interactants at the symbol system, ability of a symbol system to represent a given topic (sometimes difficult with object-based symbols), and physical or sensory limitations of either interactant. Changes in the output system for persons with deaf-blindness tend to parallel changes in the input system, since both directions of communication tend to use the same channel and means of representation.

For more information, see:

Vanderheiden, 1981, 1982, 1984

C. Environment

1. Communication Situations. Any communication system must be useable across different communicative situations if the speaker is to communicate independently. In some cases, a different aspect or presentation of a system is used in different situations, as long as the speaker is competent at each of the versions of the system. In most cases, communicative needs and

situational constraints are different in a person's living situation, educational placement, work setting, and community activities.

For some clients, the additional challenge of a different communicative setting may not only cause modifications of the system, but also facilitate development of new communicative skills. For instance, a client who has only interacted at home with familiar listeners may have no need to develop independent means of expressing complete messages (particularly if persons in that environment are skilled at anticipating possible messages). However, in the community or workplace, interaction with peers or other unfamiliar listeners may help prompt the user to more independent problem solving and resolution of communication breakdowns.

For more information, see:

Cohen, 1986

Harris, 1982

Harris & Vanderheiden, 1980

Mills & Higgins, 1984

Mirenda, 1985

Reichle & Yoder, 1979

2. Expectations/Acceptance. The various expectations from the user and persons in the environment, affect both the design of communication systems and the success with which they are used in interactions. For instance, attempts to apply signing as a communication system within a home or work environment is likely to be unsuccessful if other persons are unwilling to learn sign language. Some choices of pointing boards or electronic communication systems may fall short of user or interactant expectations of standard conversation because of slow output or unnatural-sounding speech.

Many types of expectations are task or situation-specific. For instance, in many work or education settings, good writing skills are expected but conversation skills are more flexible. With many familiar interactants, speed of communication is more important than exact message transmission because of listener skills in interpreting the message. In some cases, expectations may conflict with each other and require practical modification of the ideal situation; for instance, fast access to a large vocabulary of picture-based symbols is considerably limited by display and perceptual limitations. In many cases, expectations of both users and interactants must be discussed and modified to reflect the client's skills; depending on the communicative

history and potential of the client, this may involve either increasing or decreasing expected communicative output.

3. Listener's ability. Since communication is intended to convey a message to a listener, the means and sophistication of communication is often limited by skills of the listener. Obviously, sign language or behavioral codes would be insufficient for environments where listeners were unfamiliar with these systems. Also, written communication may pose problems for situations where listeners cannot read, such as with small children. Many listeners also have trouble with synthetic speech devices, and need to have some backup system, such as printed labels below message selections.

4. Accessibility. Even when a communication input/output method is accessible to a user, there are additional concerns about whether that access is maintained in all situations, or whether that communication allows access to all needed activities. For instance, a wheelchair-mounted communication system may provide optimal access to a board, but be inappropriate for the confines of an office working space. Symbol-based communication sets in an educational setting may be used selectively for certain tasks, and stored in a place that is not independently accessible by the user at other times.

The type of communication system may not provide access to all needed activities in the environment. Many electronic communication systems are modified so that environmental control activities such as heat or appliance operation are directed from the same system. Sign or behavioral systems may provide access to all face-to-face communication but be inadequate (with current technology) for telephone or written contact. Also, until better compatibility between computer systems is available, there is no guarantee that ability to access one computer system also allows access to a different computer.

V. Discuss Results

After limitations and possible changes for the current communication have been evaluated during a clinical assessment, the team of persons involved in a client's rehabilitation need to meet and discuss the next steps to recommend. Two decisions can be made at this stage: to instigate longer-term changes in the existing system and re-evaluate their effect before making a final decision, or to specify a recommended system and begin its application. Both of these decisions are flexible and can be changed if found inappropriate for the client. A third possibility, which exists at all levels of the decision process, is that the current system is determined to be adequate and acceptable for the client's communication needs. In this case, the decision process jumps ahead to follow-up, so that the ongoing success of the system can be monitored.

The type of system specified with persons with deaf-blindness varies according to the components of the communication system (user skills, tools, and environment). Demographic research on the use of communication systems with severe handicaps and/or deaf-blindness (Aiello, 1980; Curtis & Donlon, 1983; Matas, Mathy-Laikko, Beukelman, & Legresley, 1985) indicates that sign language and natural gestures/emotions are the most common communication approaches used with this population. Since most children with dual sensory impairments reportedly function in the severe to profound range of mental retardation, it is not surprising that few were reported to use systems requiring a high degree of cognitive and linguistic ability, such as Braille or Morse Code. Moreover, given that a majority of children with deaf-blindness function in the prelinguistic range of communication (Siegel-Causey, Ernst, & Guess, 1989; Stremel-Campbell & Matthews, 1989), it is also not surprising that many of these children surveyed (ranging from 3% - 57%) did not use any formal communication systems.

It is important to remember that the decision to use informal means of communication may be an appropriate choice for a client at any given time. In some cases, it is more important to first build increased interaction or cognitive/language skills before attempting to utilize those skills in a more formal systems. For instance, a computer-based communication system is no more than just another educational task if it is not incorporated within functional interactions. Any communication system should enhance a person's existing strategies, and can actually interfere with communicative development if drilled to the exclusion of all other skills.

Input from all personnel involved in the client's communication development is essential for this decision process. These personnel include the system user, caretakers and other frequent interactants, employers, speech-language pathologists, occupational therapists, educators, and other rehabilitation specialists involved with the case. Opinions on what may be the best system

are likely to vary between different persons, depending on what they perceive as the greatest priority. Of all the factors to be considered, among the most important are client/caretaker acceptance, and sufficiency of system for interaction needs. If the system will not or cannot be used for the ultimate goal of improving communicative interactions, then a different system needs to be considered (even at the cost of communicative effectiveness or efficiency).

Some disagreements about communication systems result from the impression that augmentative communication is synonymous with giving up the hope of achieving normal speech. In all cases, selection and application of a communication system is open to change, and nearly all systems involve multiple methods of expression (usually including speech or vocalizations whenever possible). Furthermore, most of the research to date indicates that augmentative communication systems enhances rather than interferes with speech development (Moores, 1980; Musselwhite & St. Louis, 1982; Silverman, 1980). The decision to delay further training in specific speech behaviors until prerequisite communication behaviors are established seems to provide an avenue for using future speech skills when they are developed.

For more information, see:

Kraat, 1986

Musselwhite & St. Louis, 1982

Shane & Bashir, 1980

Yoder & DePape, 1988

Yoder & Kraat, 1983

Yorkston & Karlan, 1986

VI. Fitting and Training

Much of the training for augmentative communication systems continues the changes tested in the assessment process and applies them to specific functional situations. The same factors are addressed - user skills, tools, and environment - and evaluated against the goal of functional, independent, and acceptable communication. Different persons may perform aspects of the training in different environments (teachers, therapists, parents). It is more important to help individuals within each setting become independent problem solvers about ways to improve interaction skills for a client than to try to solve all possible problems and applications before they occur.

Several general principles are often recommended when training the use of communication systems in interaction, particularly for children with deaf-blindness. Because children with severe handicaps and sensory impairments are less active and responsive to their environment than nondisabled children, caregivers may become less motivated or able to engage the child in interactive exchanges. Caregivers can be trained to provide an enriched socially responsive environment, which in turn can lead to increases in communicative behaviors in persons with severe handicapping conditions. For more information on this type of enrichment see Dunst, 1981, Reichle & Yoder, 1979, Rogow, 1982, 1983, 1984, Sternberg, Battle & Hill, 1981.

Control of computer technology or battery-operated toys has also been used to facilitate cognitive and communicative development in young children. Children that receive a consistent response contingient on their actions tend to increase their active control over their environments. While this type of activity can train deliberate control through independent play, more direct communicative stimulation is obtained by combining control activities with social interaction. By reinforcing the child with a desired social response each time a desired activity is made (such as pushing a switch) then gradually refining the desired motion through carefully scaffolded play activities, the child can learn to intentionally act to request activities with a communication system. Importantly for children with severe handicaps, this type of training activity does not depend on prerequisite acquisition of all representational skills.

Specific training to develop cognitive skills can be fostered through communication system use. Cognitive and language skill training should be closely associated, since children that receive language training following object permanence and means/end training have progressed better than children receiving language training alone (Kahn, 1978, 1984). Because aided and unaided communication systems allow for the manipulation of input features such as perceptual salience (visual, tactual), duration and abstractness, it has been suggested that such systems may simplify the task of language learning for persons with severe language impairments (Moores, 1980). Support for this notion has been provided by studies that demonstrate that training in

communication system use can lead to development/increase in communication skills. For more information, see Kiernan, 1979; Romski, Sevcik, & Joyner, 1984.

Since many persons with deaf-blindness use sign language as their communication system, it is important to consider relative difficulties and success with training different communicaiton systems. Speech training and sign language training seem to have equivalent effects on communication abilities, and Total Communication (sign plus speech) has been argued to be easier to learn (Kahn, 1977, 1981; Brady & Smouse, 1978). In general, a number of studies suggest that iconic (representational) signs are acquired faster than non-iconic signs or symbols by persons with mental retardation and severe language impairments (Griffith & Robinson, 1980, 1981; Luftig, 1983). Blissymbolics and Signed English were found in one study (Bristow & Fristoe, 1984) to be equally easy to acquire for nondisabled children. Some individuals find one system easier to acquire than the other, and teaching probes will help determine which is best for a given client.

A significant focus of any training activities should be interaction facilitation. Not only should the client be able to respond to others' messages or questions, he/she should learn to actively initiate and independently express methods. Miranda and Santogrossi (1985) have developed a strategy called "Prompt-Free Training" which maximizes the independence of the client in active communicative expression and activity control. This is particularly important for persons with deaf-blindness, who are often placed in the role of passive communicators because of poor access to communication signals in the world around them.

For more information, see:

Bambara, Siegel-McGill, Shore, & Fox, 1984

Brinker & Lewis, 1982a, 1982b

Bryen & Joyce, 1985

Deich & Hodges, 1982

Harris, 1982

Harris & Vanderheiden, 1980

Locke & Mirenda, 1988

Meyers, 1984

Mouchka, 1971

Schweigert, 1989

Siegel-Causey, Ernst, & Guess, 1989

Simpson, Holland, & Noonan, 1987

VI. Follow-Up

Once a system has been fitted and trained, or after changes are recommended for a system, rehabilitation personnel need to contact the client and training personnel to ensure that communication goals are being carried out. Follow-up activities may include telephone conversations or letters to monitor client progress, additional training for teachers or caregivers, demonstrations or trials of new techniques, feedback on success of training procedures, equipment or system modifications, or recommendations for re-evaluation of system. Since individual skills, needs, and living situations are subject to ongoing change, the follow-up phase is crucial to the development of a communication system and continues for as long as possible after a system is initially established.

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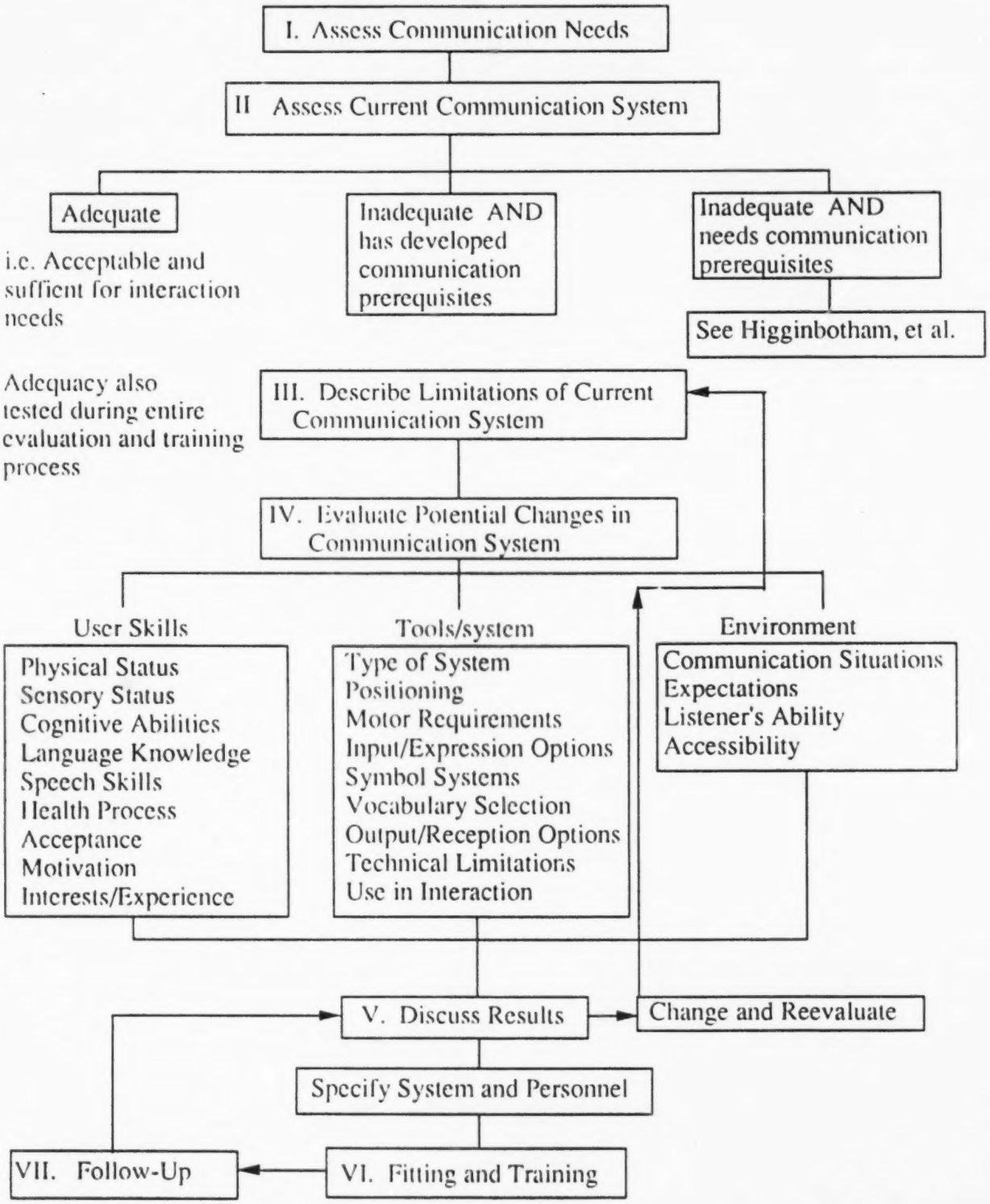
Figure 2: Decision Process for Developing Augmentative Communication Systems



Appendix 1: Communication systems used by deaf blind persons (Adapted from Jensema, 1979a, 1979b, 1980, 1981; Musselwhite & St. Louis, 1982; Nelipovich & Naegele, 1985).

SYSTEM	DESCRIPTION
Speech	Among other things, speech production and perception involve the language user's ability to associate sounds with meanings. moreover, language is generative, representing arbitrary connections among phonological, syntactic, and semantic systems.
Tadoma Method	This technique is a tactile means of decoding oral communication. The deaf-blind individual places his/her hand on the speaker's face with the thumb covering the mouth in order to fell lip, jaw and tongue movements. The other fingers are spread over the cheek, jaw and throat to detect vibrations.
Gestures/ Emotions	Gestures involve gross motor movements which can express emotions. Gestures are generally nonlinguistic, concept-oriented, action-oriented, reality-oriented and telegraphic. gestures may also include demonstrative gestures (e.g., pointing), descriptive gestures (e.g., outlining three-dimensional representations of the object), or symbolic gestures.
Sign Systems	The most commonly used signing system among the deaf community in the United States is American Sign Language (ASL). It is a language in and of itself, with a unique syntactic structure. "Educational" sign systems (e.g., Signed English, AMerican Manual Alphabet, Linguistics of Visual English, Signing Exact English) have a corpus of ASL signs, but approximate spoken English in syntax and morphology.
Fingerspelling	Fingerspelling is a tactual mode of communication, using 26 distinct handshapes to represent the letters of the Roman alphabet. Information is transmitted by placing the hand of the recipient over that of the communicator.
Total Communication	Total Communication uses a combination of sign and gestures simultaneously with spoken communication.

Morse Code	Morse Code uses a standard code of dots and dashes which represent letters and numbers. The dots and dashes can be signalled gesturally (e.g., hand/finger taps, eye blinks). Messages can be transmitted via tactual input on any part of the body, either tactually or with an electronic device which sequentially transmits the information.
Braille Hand Speech	Braille Hand Speech uses the initial, middle, and ring fingers of both hands of the receiver, inputting Braille code on a smooth surface of the receiver's body.
Cross Code	Cross code is based upon tactual input to the deaf-blind individual. The communicator taps the back of the hand or other designated place on the body with certain positions referring to certain letters. The message receiver must then interpret the meaning of the "spelled" words.
Palm Writing	The communicator uses an index finger to draw the letters of the alphabet in the palm of the deaf-blind person in order to spell out the messages.
Glove Method	The Glove Method requires the deaf-blind person to wear a glove containing alphanumeric characters. The message sender touches the letters or numbers in order to convey the message.
Pictures	Black and white or color pictures or photographs can be either abstract or highly representative of their referents. Pictures may provide an intermediate step between real life objects, events and people, and more abstract and formal communication systems.
Standard Type or Print	Handwritten or typed messages in traditional orthography can be placed on paper or a communication board.
Large Type or Print	Written orthography or typed communication can be enlarged to sizes which can be viewed within the visual field.

Braille	Braille is a system of communication based on variations of raised dots among two vertical columns of three dots each. It is primarily used as a means for reading. It can also be used in communication by using preconstructed messages or an electronic device which can transpose, in real time, type written orthography into Braille text (e.g., TelaBraille).
Symbol Systems	Symbol systems (e.g., Blissymbols, Rebuses, Picsyms, Picture Communication Symbols, etc.) represent objects, people and events by varying levels of abstractions. Some symbol systems have been incorporated into actual grammatical codes.
Communication Boards	Any device composed of displays of pictures, words, objects or other symbol systems which provide the deaf-blind person an opportunity to relate information.
Electronic Communication Boards	Electronic communication boards are composed of a symbol system display, a mechanism for the user to access the symbol system, and an electronic system to transfer/translate the message via an auditory or visual output mode.
Telephone Communication Systems	TDD's or TTY's convert typed input to an audio-frequency which is then converted back to its corresponding letter through an acoustically coupled telephone. The TelaBraille can convert the audio-frequency to Braille output, as well as accept Braille input.

Appendix 2: Communication aids for use by persons with deaf-blindness (Adapted in part from Bengston, Brandenberg, & Vanderheiden (1985); Enders (1985); Jensema (1979a, 1979b, 1980, 1981); Musselwhite & St. Louis, (1982); Nelipovich & Naegele (1985).

AID NAME	DESCRIPTION	USE	MODIFICATIONS SUGGESTED FOR SENSORILLY IMPAIRED
Activity Board (4)	Activity Board is a 5 pound portable activity center consisting of 21 three-inch squares which may be combined to form larger message areas. Activity Board may be used to operate toys or environmental controls by direct selection.	Training	Construction of custom raised-line overlays.
AllTalk (5)	A 20 pound portable communication and training aid which uses recorded human speech. AllTalk has 128 programmable areas whcih can be programmed with words or messages of the users choice. Words are accessed through direct selection.	Communication and training.	Use of tactilly discriminable symbol sets (e.g., Braille, Premack Tokens, and/or minature objects.
Alternative Keyboards (6-14)	Alternative Keyboards are designed to provide computer access for persons who cannot operate a standard computer keyboard in an effective manner. Examples of alternative keyboard include the Compudapter, Expanded Keyboard for the Apple, Keyport 717, King Keyboard, Koala Pad Touch Tablet, the MOD Keyboard, TETRAscan II, and the Unicorn I. The display area of each of the key's can be modified to provide larger smaller "keys" for the user.	Communication and training	Use of tactilly discriminable symbol sets (e.g., Braille, Premack Tokens, and/or minature objects.

Express 3 (15)	A 9.5 pound portable microprocessor based communication aid which provides written or speech output. Selections may be made, directly with a head pointer, or through row/column scanning. Contains a total of 99 programmable levels, each accepting up to 8000 characters of words or phrases. Also has a keyboard interface allowing access to standard computers.	Communication and training.	Use of tactilly discriminable symbol sets (e.g., Braille, Premack Tokens, and/or minature objects.
Omni Communicator (16)	A 10 pound portable translucent two-sided visual display communication aid. By manipulating a switch during scanning, the user is able to illuminate any of the 64 boxes on the display. Boxes can be combined to provide larger display areas.	Communication and training.	Use of tactilly discriminable symbol sets (e.g., Braille, Premack Tokens, and/or minature objects.
Optacon (17)	A portable 4 pound aid for blind people. A 6 X 20 array of pins transmits vibrotactile stimulation to the users finger tip. Requires movement of the Optacon camera to specific areas of document (including books, or computer screen).	Reading books, maps or any information provided on paper.	None
TDD's or TTY's (18-29)	A variety of TDD's or TTY's can be interfaced with other electronic devices (e.g., Versa Braille) to allow the user to converse over the telephone. Output may be printed output, stored in memory, or translated into Braille. The user also has the option of varying the rate at which the transmission (BAUD) of information occurs.	Communication (writing) over the telephone.	none

Touch Talker (30)	A 5.25 portable communicator which provides tactile feedback when accessed by direct selection is made on its 8 X 16 keyboard. Vocabulary is user definable. Selections are easily viewed on an LCD display. Options include Minspeak, Express firmware, and an RS-232C serial port which can be used to provide access to a computer. Touch Talker may also be used as a stationary printer or environmental control aid (PRC, 1985).	Communication and training.	Use of tactilly discriminable symbol sets (e.g., Braille, Premack Tokens, and/or minature objects.
Versa Braille (31)	A 10 pound portable word processor, computer terminal, read/write notetaker and printer driver. Interfaces with IBM PC, Apple, Radio Shack, and Mainframe computers. Provides a 20 character electromechanical Braille pin output. Can also print in Braille, or produce Audio output.	Writing or reading of computer documents.	None
Wolf (32)	A 2 pound portable voice output communication aid which uses the Texas Instruments "Touch and Tell" touch panel. The touch panel is made of a 6 X 6 matrix of 1.25 inch squares, which may also be grouped together for large message areas. Each area may be programmed with up to 128 characters per area. Vocabulary choices are made by direct selection, and may reside in a memory buffer for any period of time.	Communication and training	Use of tactilly discriminable symbol sets (e.g., Braille, Premack Tokens, and/or minature objects.

Manufacture address listing

Reference Number	Aid Name	Vendor/Address
1.	Votrax Type-'N-Talk	Votrax Consumers Products 500 Stephenson Highway Troy, MI. 48084 (800) 521-1350
2.	Echo II	Street Electronics 1140 Mark Avenue Carpinteria, CA. 93103 (805) 684-4593
3.	DecTalk	Digital Equipment Corp. 146 Main St. Maynerd, MA. 01754 (800) DIGITAL
4.	Activity Board	Contemporary Artistic Technology Co. Ltd. P.O. Box 58430, Station L Vancouver, British Columbia V6P 6K2 Canada (604) 324-8119
5.	AllTalk	Adaptive Communication Systems, Inc. 994 Brakhead Road, Suite 202 Coraopolis, PA. 15108 (412) 264-2288
6.	Compudapeter	Martin Gale R/M Systems 22903 Farm Avenue Torrance, CA. 90505 (213) 534-1880
7.	Expanded Keyboard for the Apple	EKEG Electronics Co. LTD. P.O. Box 46199 Vancover, B.C. V6R 4G5 Canada (604) 685-7817
8.	Koala Pad	Koala Technologies Corp. 3100 Patrick Henry Drive Santa Clara, CA 95050 (408) 986-8866
9.	Keyport 717	Instructional Computing Services P.O. Box 10998-477 Austin, TX. 78766 (512) 250-8601

10.	King Keyboard	TASH, Inc. 70 Gibson Dr. Markham, Ontario L3R 2z3 Canada (416) 475-2212
11.	MOD Keyboard System	TASH, Inc. 70 Gibson Drive Markham, Ontario L3R 2Z3 Canada (416) 475-2212
12.	PowerPad	Ben Satterfield Chalk Board, inc. 3772 Pleasantdale Rd. Atlanta, GA. 30340 (800) 241-3989
13.	TETRAscan II	Zygo Industries, Inc. P.O. Box 1008 Portland, OR. 97207 (503) 297-1724
14.	Unicorn Expanded Keyboard	Unicorn Engineering Co. 6201 Harwood Ave. Oakland, CA. 94618 (415) 428-1626
15.	Express 3	Prentke Romich Company 1022 Heyl Rd. Wooster, OH. 44691 (216) 262-1984
16.	Omni 3	Communication Research Corporation 1720 130th Avenue, N.E. Bellevue, WA. 98005 (206) 881-9550
17.	Optacon	Telesensory Systems Inc. 455 North Bernardo Avenue P.O. Box 7455 Mountain View, Ca. 94943
18.	Am-Com I	American Communication Systems, Inc. 994 Broadhead Road, Suite 202 Coraopolis, PA. 15108 (412) 264-2288
19.	Echo 2,000	Palmetto Technologies, Inc P.O. Box 498 Duncan, SC. 29334 (803) 439-4309

20.	Intele-Type	Ultratec, Inc. 6442 Normandy Lane Madison WI. 53719 (608) 273-0707
21.	LUV I	American Communication Corporation 180 Roberts Street East Hartford, CT 06108 (203) 289-3491
22.	Minicom II	Ultratec, Inc. 6442 Normandy Lane Madison WI. 53719 (608) 273-0707
23.	Miniprint	Ultratec, Inc. 6442 Normandy Lane Madison WI. 53719 (608) 273-0707
24.	Porta Printer Plus/Model	Krown Research, Inc. 6300 Arizona Circle Los Angeles, CA. 94005 (213) 641-4306
25.	SSI-100 Communicator	Specialized Systems, Inc. 6060 Corte del Dedro Carlsbad, CA. 92008 (619) 438-8800
26.	SSI-200 Communicator	Specialized Systems, Inc. 6060 Corte del Dedro Carlsbad, CA. 92008 (619) 438-8800
27.	SSI-240 Communicator	Specialized Systems, Inc. 6060 Corte del Dedro Carlsbad, CA. 92008 (619) 438-8800
28.	Superphone B/X	Ultratec, Inc. 6442 Normandy Lane Madison WI. 53719 (608) 273-0707
29.	Trendcom	3M Company Business Communication Products 3M Center St. Paul, MN. 55144 (612) 733-5454

APPENDIX 3

Heirarchy of tactile exploratory behaviours and tactile perception skills from early to later development.

Behaviours	Skills
Grasp	Manual manipulation of objects, recognition of familiar vs. novel objects.
Stroking with open palm.	Rough texture & temperature discrimination.
Reaching, grasping, rotation of arm & hand.	Play exploration, functional use of objects.
Exploration with palm only.	Texture, temperature discrimination. Recognize familiar objects.
Exploration with palms & also rolling, pulling pushing.	Discriminate circles from squares, firmness vs. softness.
Palpation, cupping, pressing spanning of object.	Differentiate shapes by angles, some discrimination of width, distance, length.
Tracing with fingertips, use of hand to measure & weigh.	Discrimination of fine texture differences, shape, accurate judgement of length, width, distance.
Adopt global grasping touch or fine finger movement for structural analysis.	Recognize all material & formal qualities, engage in high level tactile skills - braille, maps.

From Iacono, T. (1989) Tactile symbols in augmentative system use. Unpublished paper, University of Wisconsin-Madison.

APPENDIX 4

GUIDELINES FOR MOTOR ASSESSMENT

Jennifer Angelo, Ph.D, OTR

1. General Background Information should be collected.

2. What is the purpose of Interface?

   Reading, conversation, writing, computer access, drawing, call system?

3. What is the client's current system?

   Does s/he have a reliable yes/no response?

   Does s/he vocalize, use gestures?

   What devices does s/he currently use: non-electronic or electronic?

4. What is the client's general cognitive level?

5. What is the client's variety and quality of available movement for:

   head & neck

   eyes, mouth and jaw

   right upper limb/hand

   left upper limb/hand

   right lower limb

   left lower limb

What is the overall body tone and function?

6. Does the client have contractures or deformities which hinder control and movement?

7. Which body part under the most voluntary control?

8. What is the client's position in which s/he is most effective (reliable) using this limb?

10. What is the best position of the switch in relation to the body part?

11. What is the client's rate of efficiency with one switch over another switch using the same body part?

12. What is the effect of voluntary movement on associated movement throughout the body?

13. What are the reflexes and involuntary movement that are noted while the client is trying to activate the switch?

14. What position is the communication device in when the client most effectively uses it?

15. How long can the client work before s/he fatigues.

16. What is the size of smallest target the client can accurately press?

17. How many target points can the client can discriminate between? The number of target points can be limited by the clients range or by their mental capacity to remember what different switches represent.

18. How much space does there need to be inbetween input targets so that the client does not hit one by mistake?

19. What is (are) the type(s) of switch(s) the client can most reliably hit?

20. How many different textures can the client discriminate between?

21. How many positions is the client in while needing to use communication device?

22. Does the aid need to be portable?

Will the client be using the aid in one environment or several?

How will they transport aid?

Do they need their hands free for mobility devices?

23. What is the durability of the aid?